

HOUSE OF COMMONS SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY

INQUIRY INTO THE PARTICLE PHYSICS AND ASTRONOMY RESEARCH COUNCIL (PPARC)

ANNEX TO SUPPLEMENTARY MEMORANDUM BY PPARC

Summary

This Annex summarises the findings of recent surveys and statistics not available at the time of writing the main PPARC Memorandum, concerning:

- (a) the academic community supported by PPARC;
(about 40% the total for physics, in good health)
- (b) factors influencing the choice of physics at undergraduate level;
(dominant importance of PPARC subjects)
- (c) international comparisons of the standing of UK astronomy and the UK particle physics community.
(the UK very cost effective and highly regarded)

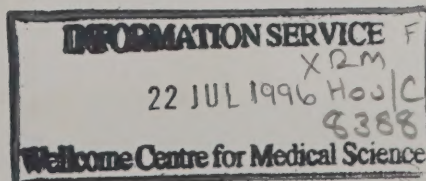
(a) The academic community supported by PPARC

1. Table 1 attached gives a statistical overview of the number of institutions, tenured staff, research assistants (RAs), Fellows and PhD students directly and indirectly supported by PPARC. Table 2 (taken from PPARC Annual Report Appendix 2) shows the distribution of PPARC support between institutions.

2. Several points are worth noting:

- the community represents about 40% of the total for all physics;
- it is divided very roughly 3:2 astronomy: particle physics;
- some level of support reaches a total of nearly forty different institutions;
- but the bulk (about 80%) is concentrated in the top 10 universities. Six physics departments in those universities were marked Grade 5 in the most recent Higher Education Funding Council Research Assessment Exercise and four were marked at Grade 4.

3. It is PPARC policy, particularly in astronomy, that while resources are concentrated in a relatively few key centres - for obvious cost-effective reasons - support is also available on a competitive basis to small groups even individual workers in any university. The individual or small group in astronomy can still make valuable contributions to research, not only in theory. PPARC is committed to accepting valid research grant applications from any university capable of supporting them.



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Recent growth in the community: new academic appointments

4. A recent survey of university physics departments has revealed that a total of 11 new Professors and 53 Readers, Senior Lecturers and Lecturers have been appointed in the UK over the last four years in astronomy; and 3 Professors and 34 Readers, Senior Lecturers and Lecturers appointed in particle physics.

5. These figures argue both for the present health and likely future vitality and UK role in these subjects, but also for universities' recognition that astronomy, in particular, is a significant factor in influencing undergraduate choice of courses and hence an aid to recruitment (see also below). With a total of some 560 academic posts and an average of 35 years tenure, an average rate of recruitment would be 16 appointments per year. The higher recent average of 25 per year shows the real growth in the community. Moreover, because recruitments are being made from different age bands, the age distribution is becoming healthier and a generation of new research leaders is being put in place.

6. There is also evidence that those physics departments which have (introduced) an astronomy option/module have suffered less than others, if at all, from the general decline in physics student intake.

(b) Factors influencing the choice of physics at undergraduate level

7. A survey conducted for the Institute of Physics in 1984 revealed the large extent to which topics in the PPARC area influenced school leavers' choice of physics for undergraduate study. PPARC repeated the same survey, with some updating, in November 1995. The results show that the influence of PPARC topics has slightly increased over the period. In 1995 65% of students cited 'Relativity and Gravitation' as influencing their choice (55% in 1984), and 55% cited Astronomy, astrophysics, cosmology and space research (40% in 1984). The other favourite topics were Quantum Theory (cited by 43%) and Elementary Particles (34%). Rather surprisingly, more applied aspects such as Electronics (14%), (Optics 12%), Nucleus and nuclear energy (16%) scored significantly lower, and showed a decline in appeal since 1984. Table 3 shows the scores for each topic. (Full copies of the reports are available.)

8. Other findings to emerge were:

- a marked preference for the new MPhys/MSci courses amongst students with an interest in PPARC topics;
- a **decline** in the influence of school text books in affecting choice, coupled with an **increase** in influence of popular science books and journals - a finding which should interest both school teachers, publishers and PPARC.

9. Overall these findings confirm and reinforce PPARC's view that the subjects which it supports are a major factor in influencing young people's choice of physics at university. PPARC intends to follow-up this study with a similar study on factors influencing the choice of physics A-level at school. This should quantify our belief that the same positive influence of PPARC science is found at schools level, with consequent benefits for a much wider area of training, including subsequent undergraduate course recruitment in eg engineering.

(c) International comparisons of the standing of UK astronomy and the UK particle physics community

10. Two recent surveys have confirmed the high international standing of the UK scientific communities in astronomy and in particle physics. Because of the very different ways in which research is undertaken and reported in particle physics and in astronomy the surveys cannot easily be compared one with the other.

(i) Bibliometric analysis of the relative standing of UK astronomy 1981-1993

11. The results show that not only has UK astronomy increased its world standing as measured by publication analysis, it has also increased in comparison to other research areas in the UK.

12. Research results in astronomy are still predominantly reported in specialist, refereed journals. A measure of a research paper's impact is the number of times which subsequent authors cite that paper. Publication and citation analyses are now accepted as broad indicators of the perceived standing of different countries or large groups. The National Audit Office (NAO) recent Discussion Paper "PPARC: Performance Measurement" (December 1995) proposes 'bibliometric analysis - publication counts or citation rates' as a corporate performance indicator for astronomy research (para 2.19).

13. A recent PPARC study has used both the number of papers and number of citations to compare the UK's performance in astronomy with that of other countries and the UK's international standing in astronomy with its international standing in other fields. The details and a complete set of analyses are given in the full report (available on request). The main conclusions are summarised below and in the four graphs attached (Figures (i) - (iv)).

14. In terms of its share of the world astronomy literature over the period, the UK ranked second to the USA and, apart from a dip in the mid-1980s, has been maintaining that position (Figure (i)). The average number of citations per UK paper increased over the period and by 1993 the UK was also in second place to the USA by this performance measure, having recently moved ahead of the Netherlands (Figure (ii)).

15. The UK's international standing in astronomy, as measured by publication share, was, apart from the mid-1980's dip, higher than that for other scientific fields (grouped together according to UK Research Council areas, see Figure (iii)). Measured by citations/paper (relative to the world average), the UK's international standing in astronomy was by 1993 ranking second behind the average for MRC sciences (Figure (iv)); having begun the period lower than the averages for all other Research Council areas. (Note that the database used includes particle physics within physics and that physics has been included in the EPSRC figures, although the effect is likely to be small).

16. These results seem to show that UK astronomy has been able to increase its relative standing both nationally and internationally, despite the fact that its share of the UK Science Budget has been declining. This would imply a reflection both on the scientific excellence of the community and a comment on its cost-effectiveness.

(ii) Statistics on UK standing in experimental particle physics

17. The scale of modern particle physics research is such that the role of an individual in an experiment, and the published results is much more difficult to assess. The NAO paper on performance indicators (above) notes, in para 2.22, that: "Experimental particle physics presents particular problems. First, experiments are carried out by international collaborative teams involving hundreds, even thousands, of scientists. All those working on an experiment tend to be listed, often in alphabetical order, as authors in publications regardless of the actual level of input; hence unsophisticated bibliometric techniques are of little use. And secondly, publication rates vary throughout the cycle of experiments. For example, construction for an experiment can take ten years, when there may be relatively few publications."

18. NAO recommend UK contributions to international conferences or UK representation on CERN scientific committees as possible performance indicators for particle physics.

19. Statistics recently collected by PPARC and summarised in Table 4 reveal that France and Germany spend more than three times and Italy four times as much as UK on domestic experimental particle physics (despite Italy having a lower GDP). In Italy and Germany, manpower in domestic PP is over twice that of UK; in France one and half times.

20. Despite that advantage, Table 4 bottom line shows that UK scientists are on average represented at over twice their 'pro-rata' level in CERN experiments for both LEP and LHC. The more detailed figures show that for the Delphi (LEP) experiment, for example, UK scientists are on 21% of the relevant committees and teams, although the UK is contributing only 8.5% of the funding - a ratio of 2.49. For the LHC CMS experiment the comparable figures are 7.4% representation against 2.9% funding. On the three key CERN committees, UK scientists represent over 18% of the membership, against a funding contribution of about 14%.

21. At the major international (Rochester) particle physics conferences, the UK naturally falls some way behind the USA in terms of convenors and plenary papers, (usually fielding just under a quarter of the US total), but over the period since 1992 has consistently fielded more than France (ratio 1.62) Germany (1.17) and Italy (2.1).

22. Even allowing for the advantage which the English language gives UK scientists, the conclusion is that the UK community is achieving well beyond the pro-rata share of involvement and international recognition that would be expected from the funding provided.

23. Full details of the statistics are available.

Table 1

The PPARC Research Community

UNIVERSITIES	Number of Institutions	Tenured Research	RA	Fellows	Students (PhD)
Astronomy and Astrophysics	33	232	186	not	possible
Solar Terrestrial Physics	21	46	91	to desegregate	
Planetary Science	21	53	61		
Total	38	331	338	39	278
Theory (included in above)	29	170	112		
Particle Physics	17	147	162	17	131
Experimental Particle Physics Theory	12	84	24	22	48
TOTAL	18	231	186	39	179
Total PPARC supported		562			
Total all physics	51	1175			
CCLRC				-	-
Astronomy	-	10	0	-	-
Particle Physics		22	15	-	-
Royal Observatories	-	7	5	-	-

NEW ACADEMIC APPOINTMENTS OVER PAST FOUR YEARS (mid 1992 - mid 1996)

	Professors	Readers, Senior Lecturers & Lecturers
Astronomy & Planetary Science	11	52
Particle Physics	3	34

APPENDIX 2 - STATISTICAL INFORMATION

Table 1: Distribution of PPARC support to universities (research grants, studentships and fellowships) as at 31/3/95
 The list is ordered by grant expenditure in £ thousands
 All data as at 31/03/95

EXPENDITURE IN 1994/95 INSTITUTION	RESEARCH GRANT		CURRENT STUDENTSHIPS		ADVANCED TOTAL COURSE	POSTDOC	CURRENT FELLOWSHIPS		TOTAL	MAIN AREAS RESEARCH GRANT ACTIVITY (see below for key)
	PARTICLE PHYSICS	ASTRONOMY & SPACE	RESEARCH	CASE			ADVANCED	SENIOR		
UCL	761	4440	20	4	3		2			B, C, D, E, I, J
MANCHESTER	1080	2958	25	1	31			1	2	A, C, D, E, F, G, I, J
ICSTM	1383	2122	34	5	5		2		3	B, C, D, E, F, G, H, I, J
LEICESTER		3399	15	5	20		1			B, C, D, E, F, G
OXFORD	1880	1252	36	3	39		5	2	9	B, C, D, E, F, G, H, I, J
CAMBRIDGE	578	2401	50		50		10	1	14	B, C, D, E, F, G, I, J
QMWC	742	1180	1922	26	28		3		3	B, C, D, E, F, G, I, J
BIRMINGHAM	653	1012	1665	17	20		1		2	B, C, D, E, F, G, I, J
DURHAM	177	1297	1474	24	24		2	1	3	B, C, D, E, F, G, I, J
LIVERPOOL	1166		1166	11	12		3	1	7	I, J
GLASGOW	476	530	1011	16	19		2		3	B, C, D, E, F, G, I, J
SHEFFIELD	183	519	713	8	10		3			B, E, G, H, I, J
SUSSEX	185	593	704	13	18		2	1	5	B, C, D, E, F, G, I, J
KENT			593	5	6		2			C, E
EDINBURGH	282	139	421	19	19				2	E, F, G, I, J
SOUTHAMPTON	112	300	412	12	16		3	1	4	B, D, F, G, I, J
LANCASTER	282	129	411	5	5					B, E, G, I, J
OPEN	6	308	314	4	5					C, J
ST ANDREWS		299	299	9	9		1	1	4	B, D, E
BRISTOL	208	56	264	7	7		1		1	E, I, J
ROYAL HOLLOWAY	218	20	238	2	2					G, I, J
QUEENS UNIVERSITY BELFAST		233	233	1	1					B, D, E, F, G
CARDIFF		230	230	8	9					D, E, G
BRUNEL	187		187	2	3					I, J
ABERSTWYTH		155	155	5	6					B
UMIST		141	141	1	1					B, E
HERTFORDSHIRE		132	132	2	2					D, F, G
YORK		125	125	2	2					B
NEWCASTLE		121	121	3	3					C, E
LIVERPOOL JOHN MOORES		115	115	2	2		1		1	C, D
LEEDS		110	110	7	7					E, G
ARMAGH OBSERVATORY		78	78	1	1					D
KEELE		61	61	2	2		2		2	D
SWANSEA	60		60	5	5		3		3	G, J
KING'S COLLEGE	39		39	2	2		1		1	C
EXETER		27	27							E, G
NOTTINGHAM		25	25							D
LANCASHIRE		24	24							G, J
ASTON		0	0	3	3				1	C
TOTAL	10658	25066	35724	404	37	15	46	8	71	E, G

Key for areas of research grant activity:

A - astronomy, celestial mechanics, databases and survey astronomy

C - planetary science

E - galactic and inter-stellar astronomy

G - physics and physical processes not specifically astronomy, planetary science or particle physics

I - the origin of mass

B - solar and solar-terrestrial physics

D - stars

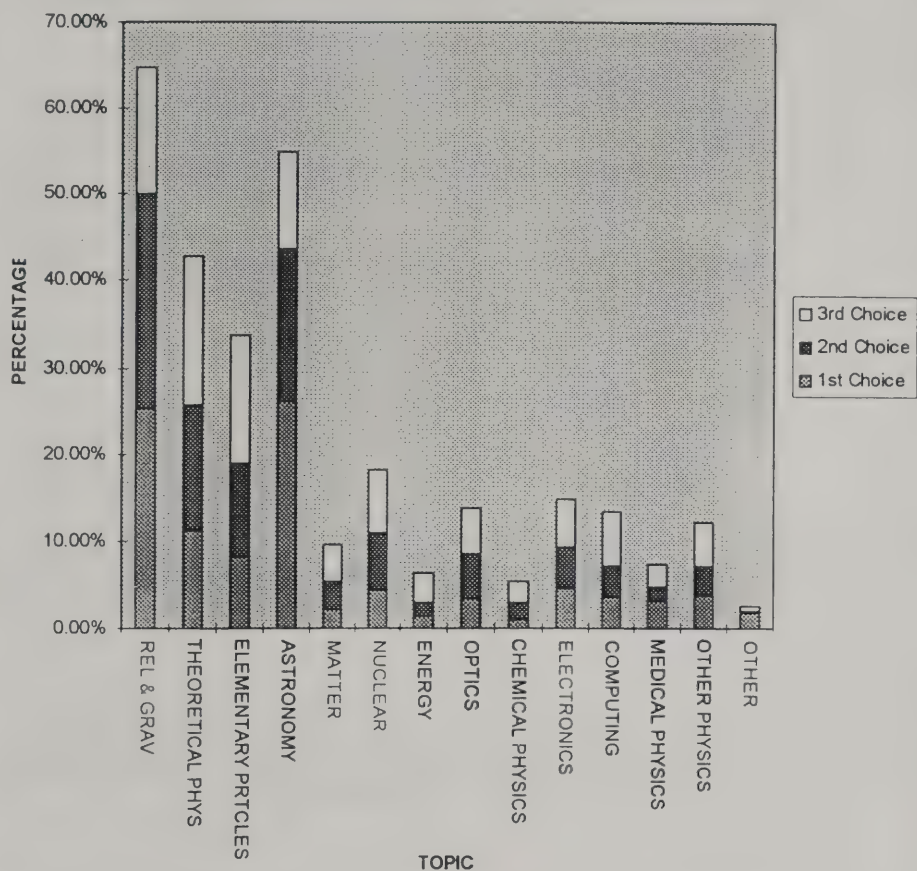
J - extra-galactic astronomy and cosmology

I - dark matter

J - the three generations and weak symmetries

Percentage of students with first class degree (as at 01/10/94) 59%
 Completion rate performance (as at 01/10/94)..... 78%

TOPICS THAT INFLUENCED THE CHOICE OF PHYSICS 1995 SURVEY



TOPICS KEY:			
A	RELATIVITY AND GRAVITATION	B	QUANTUM THEORY, OTHER THEORETICAL PHYSICS
C	ELEMENTARY PARTICLES	D	ASTRONOMY, ASTROPHYSICS, COSMOLOGY & SPACE RESEARCH
E	MATTER	F	THE NUCLEUS, NUCLEAR ENERGY
G	CONVENTIONAL & ALTERNATIVE GENERATION OF ENERGY SOURCES	H	OPTICS
I	ATOMS, MOLECULES, CHEMICAL PHYSICS	J	ELECTRONICS
K	COMPUTING	L	MEDICAL AND BIOLOGICAL PHYSICS
M	PHYSICS OF OTHER DISCIPLINES	N	OTHER

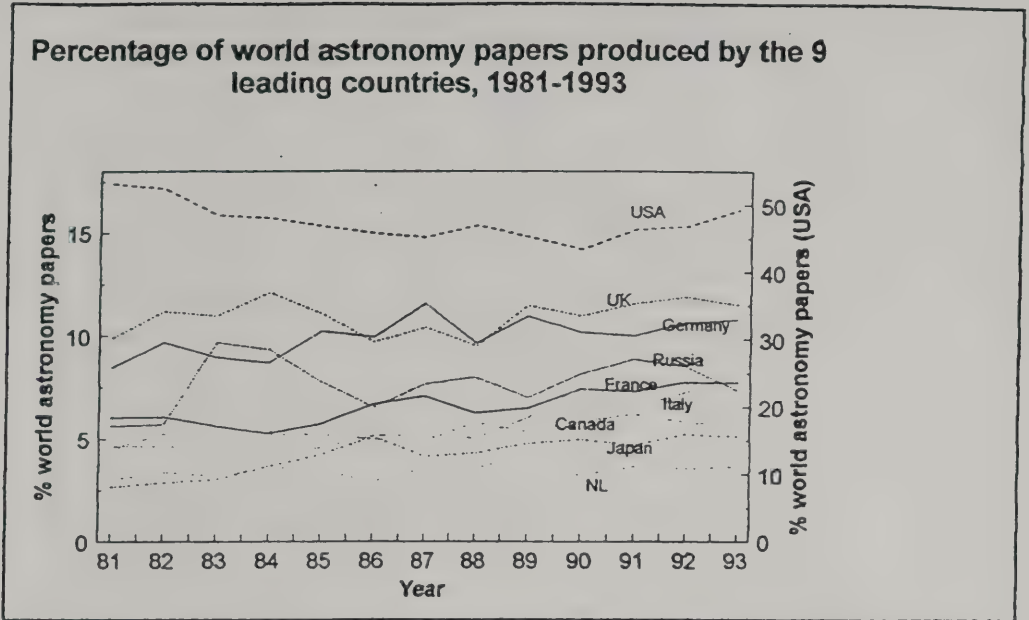


Fig. (i) Percentage of the world's astronomy papers with at least one author from each of the nine most prolific countries. Note that the USA is on a separate scale.

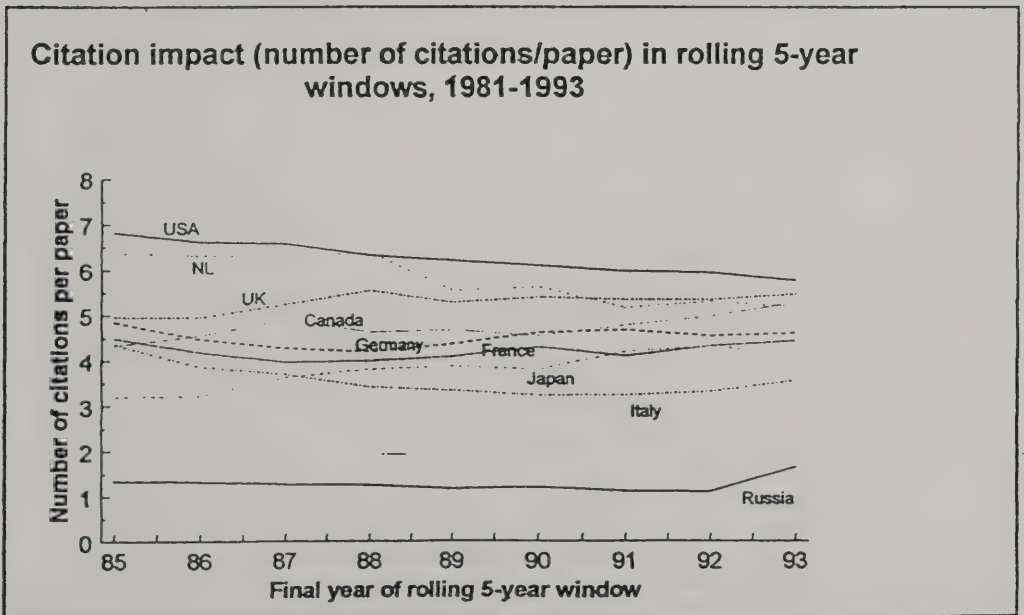


Figure (ii) Number of citations/paper for the nine leading countries in rolling five-year overlapping periods starting in 1981.

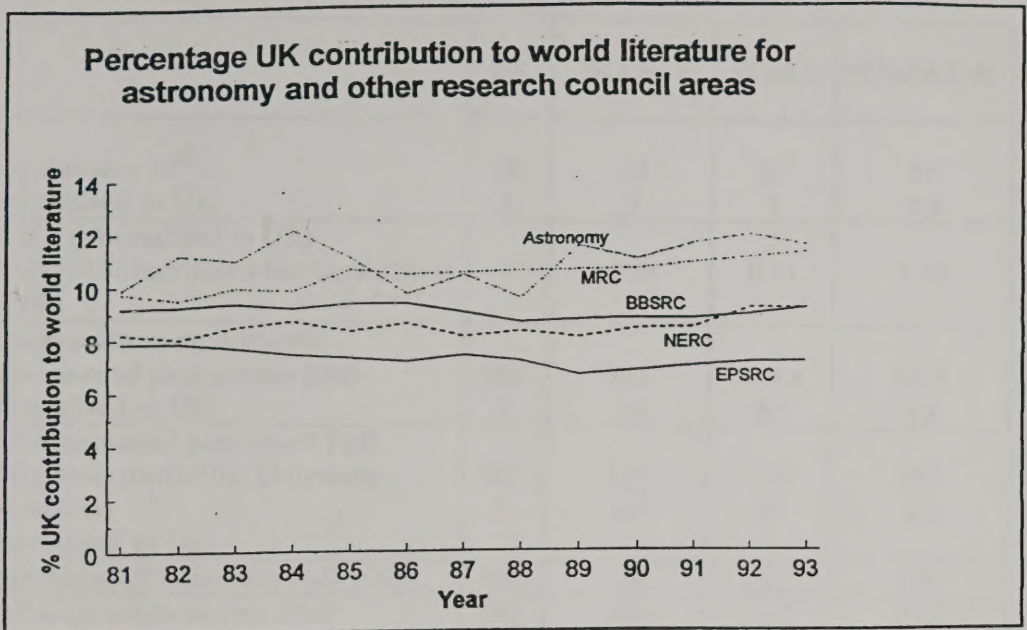


Figure (iii) UK astronomy papers as a percentage of the world astronomy literature compared with the overall percentage UK contribution to the world literature for fields falling within other research council areas.

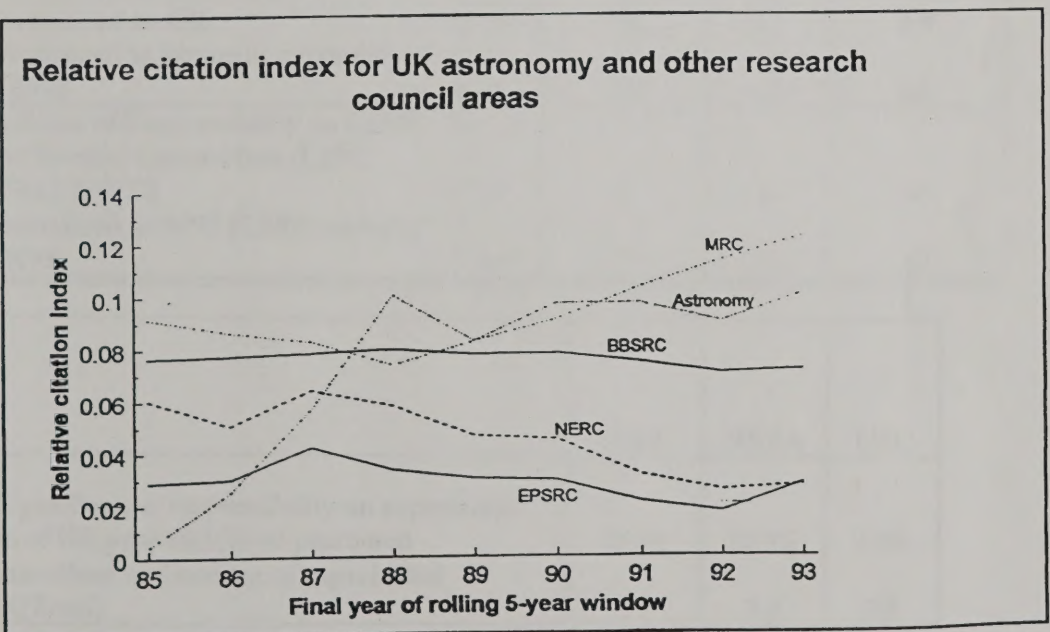


Figure (iv) Relative citation index for UK astronomy and average relative citation indices for fields falling within other research council areas, in overlapping five-year periods. The relative citation index is the log of the ratio of citations/UK paper to citations/all papers.

Table 4

Comparisons of UK, French, Italian and German domestic experimental particle physics programmes and relative output indicators

	UK	FRANCE	ITALY	GERMANY
Population x 10 ⁶ Normalised to UK	58 1	57 1	57 1	81 1.4
N.N.I. (Normalised to UK) (= CERN Subscription but Germany at 26.1%)	1	1.28	0.93	1.96
(1)Expenditure on domestic experimental programme (£M) Normalised to UK	25.8 1	82.5 3.2	115.3 4.5	81.9 3.2
(1)Experimental permanent PhD Manpower (including University academics) Normalised to UK	247 1	417 1.7	705 2.9	592 2.4
Expenditure/Permanent PhD (£K)	104	198	164	138
(1)Total manpower (inc. PhD students) Normalised to UK	786 1	1284 1.6	2067 2.6	1687 2.1
(2)Speakers and convenors at 4 recent international conferences Normalised to UK Normalised to domestic expenditure (UK=1)	21 1 1	13 0.6 0.2	10 0.5 0.1	18 0.9 0.3
Positions of Responsibility on CERN Peer Review Committees (LEPC, SPSLC, LHCC) Normalised to NNI (CERN contrib) (UK=1)	8 1.0	8 .78	6 .70	9 .57

	LEP	HERA	LHC
UK positions of responsibility on experiments (No of UK people)/(Total positions) Normalised to funding of experiment (UK/Total)	36.1% 2.2	23.9% 1.9	7.4% 2.2

(1)Excludes operation of HERA and associated infrastructure of DESY and salaries of University academic staff.

(2)These are plenary speakers and parallel session convenors at 4 of the most recent major international particle physics conferences (3 Rochester + 1 Europhysics). In comparison, the total number of US speakers in these conferences was 85.

